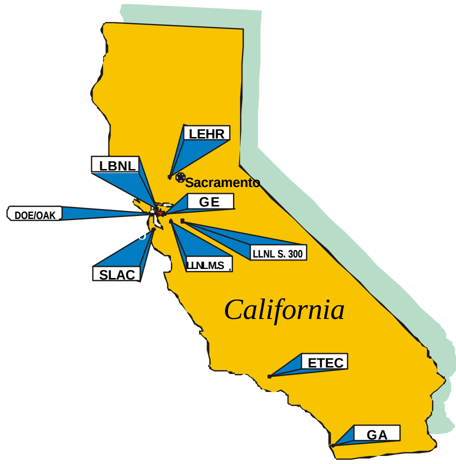
Significant S&T Activities at Oakland Operations Office

March 2001



Lawrence Livermore National Laboratory (LLNL), Main Site

Clean Up Volatile Organic Hydrocarbons in Soil and Groundwater

Between 1952 and 1979, tens of thousands of liters of gasoline leaked from an underground storage tank at a former LLNL filling station. Attempts were made to use pump-and-treat method but few insufficient contaminants were removed. **Dynamic Underground Stripping (DUS)** (SCFA, ID: 7) was introduced in September 1991 to rapidly remove the gasoline from beneath the LLNL site. In DUS, a targeted volume of earth is heated to vaporize the trapped contaminants. Once vaporized, the contaminants are removed by vacuum extraction. All processes, from the heating of the soil to the removal of the contaminated vapor, are monitored and guided by use **of Electrical Resistance Tomography (ERT)** (CMST, ID: 17). ERT was deployed to provide real-time process control for the patented Dynamic Stripping process at the Gas Spill Site. No other technology exists that provides noninvasive 3-D imaging allowing control of steam injection flow rates. Results completed in June 1993 indicate that the process is 50 times as effective as the conventional pump-and-treat process. The combination of DUS and ERT removed over 7000 gallons of gasoline in 10 weeks of operation saving close to $15M.

Destruction of Organic Components of Hazardous or Mixed Waste Streams

Direct Chemical Oxidation (DCO) (MWFA, ID: 109) is a technology for the destruction of organic solids and liquids. The process uses peroxydisulfate as the oxidant to destroy organics, operates at below 100 degrees Centigrade and at atmospheric pressure. DCO is considered a nonthermal, aqueous-based process which uses the nearly "omnivorous" oxidant peroxydisulfate to mineralize any organic solid or liquid, including nitrated-, sulfated and chlorinated wastes, plastics, and carbon chars. The process uses no toxic catalysts and secondary wastes are avoided by recycling the sulfate product into peroxydisulfate. The integrated DCO process (including hydrolysis) was demonstrated in FY 1998 on the pilot-plant scale (at a destruction rate of 15 kg of carbon/day), using LLNL waste streams or surrogates containing chlorinated solvents.

Characterize Soil and Groundwater to Help Cleanup Contamination

Colloidal Borescope (SCFA, ID: 465) is an innovative technology deployed in FY 1998 to determine ground-water flow and direction through observation of the movement of colloidal particles suspended in water.

Current applications include: site characterization by determining preferential flow paths and fractures; assessing heterogeneities associated with porous media; establishing the existence of immiscible contaminant layers and their associated flow properties; assessing the efficiency of ground-water remediation programs by determining the effective radius of influence of ground-water extraction systems; and evaluating the effects of sampling on colloidal concentrations. Potential applications include providing physical observation capabilities necessary to develop and confirm new, more accurate theoretical models of porous media flow process, and assessing the effect of water sampling techniques on natural colloidal concentrations.

SimulProbe™ Technologies International, Inc. (STI) has developed an innovative sampling device, SimulProbe™ that can collect soil core simultaneously with soil vapor or ground water samples. Once collected, SimulProbe™ technology keeps the samples isolated from drilling fluids, ground water and atmosphere within the borehole, thereby assuring the chemical integrity of the samples. In situ air permeability measurements can also be collected while collecting soil vapor samples.

During a drilling program in February 1998, the SimulProbe™ was deployed for subsurface sampling to collect *in situ* vapor samples and *in situ* air permeability measurements at a site impacted by the past release of volatile organic compounds (VOCs).

Cleanup of Chlorinated Hydrocarbon from Fine-Grained Sediments in Plume Source Areas
Electro-Osmosis (EO) System (SCFA, ID: 2923) is a means for extracting contaminants from fine-grained, low-permeability sediments. The EO system was installed near a suspected chlorinated hydrocarbon plume source area at LLNL during the spring and summer of 2000. Electro-osmotic pumping of pore water occurs when the positively charged diffuse layer of ions associated with the surfaces of clay minerals is drawn toward the cathode (negatively-charged electron) in an applied electric field. The well field consists of 9 wells: 6 injection wells (anode) and 3 extraction wells (cathode). Extracted groundwater is treated in a portable treatment unit (PTU) that removes chlorinated hydrocarbons by air-stripping with activated carbon adsorption. Treated water is returned to the subsurface by injection at the anode wells to facilitate water management. The estimated operating time for the EO array is approximately three years. There is reason to believe that electro-osmotic pumping may offer a 10- to 100-fold improvement in the rate of contaminant extraction at the deployment site that would otherwise not be amenable to remediation by hydraulic pumping.

Lawrence Livermore National Laboratory (LLNL), Site 300

Pond Liner Leak Detection
Electrical Resistance Tomography (CMST, ID:17) is a technique based on the measurement of electrical resistance in the soil and rock, which has been developed for site characterization and monitoring of the remediation processes in the subsurface. Electrical Resistance Tomography (ERT) was deployed at LLNL Site 300 Infiltration ponds in July 1997 to detect leaks in the pond liner. The actual electromagnetic technique used is called excitation of mass and is a separate patent from other ERT patents. ERT was deployed to provide real-time process control. No other technology existed that could have provided noninvasive 2- and 3-dimensional imaging of leaks through a pond liner.

Analysis of Ground Water Flow Patterns
The **Colloidal Borescope** (SCFA, ID: 465) directly observes suspended colloids (particles generally 1 to10microns [µm] in size) to measure real-time local ground water flow direction and velocity in a monitor well. In addition, the borescope can be used to observe colloid mobilization during well sampling and ground water pumping. Lawrence Livermore National Laboratory, Oak Ridge, and RJ Electronics have jointly developed a borescope capable of imaging multiple intervals without repositioning the instrument. This variable-focus borescope has been in use at LLNL Site 300 since the mid-1990s. LLNL has used, and continues to use the borescope to help analyze ground water flow patterns in the General Services Area and at Building 854. These investigations were useful in optimizing ground water extraction well placement, and in locating additional monitoring wells to delineate contaminant plumes.

Remediation of Ground Water Consisting Primarily of Volatile Organic Compounds
Iron Filings/GeoSiphon Treatment System (SCFA, ID: 2156/2063) is a technology for the treatment of chlorinated volatile organic compounds (CVOCs). The iron reduces the CVOCs to ethane, ethene, methane, and chloride ions in the degradation of trichloroethylene (TCE), which is the primary contaminant of concern. This zero valent iron enhances abiotic degradation of CVOCs and is essentially a reductive dechlorination process, which uses the granular cast iron as the reducing agent. The degradation of CVOCs is the result of surface activated reaction, where the reductive dechlorination process requires the adsorption of the CVOCs onto specific active surfaces on the iron filings. The system, deployed in July 2000, entails extracting ground water from three artesian wells located in the Building 832 Canyon and piping the water to the treatment system. The treatment system consists of a series of aboveground iron-filing filled drums manifolded in parallel as primary treatment. In addition to the iron-filled drums, two granular activated carbon drums are manifolded in parallel as secondary treatment and sand bed filters and aeration towers for the removal of iron oxides are used in the treatment process. The system requires little operations and maintenance, no electrical power, and takes advantage of the canyon's hydrogeological and topographic conditions to drive the system. This "green" technology will reduce capital and operational costs while minimizing impact to the surrounding environment.

Laboratory for Energy Related Health Research (LEHR)

Removal of Soil Contaminated with Strontium-90
The **BetaScint Fiber Optic Sensor for Detecting Strontium-90 and Uranium-238 in Soils** (CMST, ID: 70) sensor was used for screening samples to determine the extent of excavation needed to remove Sr-90 contamination, and for confirmation sampling to verify that all Sr-90 contaminated wastes and adjacent Sr-90 contaminated soil had been removed. This technology provides real-time results on site without the need of expense analytical laboratory facilities. The BetaScint and gamma spectrometer onsite tools were instrumental in maintaining labor and heavy equipment efficiency and minimizing waste volumes. Reduced number of verification samples required. Around 33% cost reduction (~$250K). This technology was used for monitoring progress of removal of Sr-90 and Ra-226 (paired with gamma sensor) contaminated soils at U. C. Davis LEHR (1999).

Lawrence Berkeley National Laboratory (LBNL)

Treatment of Combustible Mixed Low-Level Waste
Catalytic chemical oxidation (CCO) offers an alternative to incineration for the treatment of combustible mixed low-level waste. CCO uses the reaction of oxygen, or an alternate oxidizing agent, to destroy the organic constituents of a waste in aqueous solution. In catalytic chemical oxidation one or more chemical species are added, which act to increase the rate at which the oxidation reactions proceed. This technology eliminated organics from 15.3 liters of highly tritiated mixed waste streams at LBNL. Because of the high levels of tritium activity, these waste streams could not be treated in DOE or other commercial facilities. LBNL had these wastes delisted by the state of California so that LBNL can manage these wastes as low-level waste. The **Thermal Oxidation of Organics Using Catalytic Chemical Oxidation** (MWFA, ID:2040) was applied to four mixed waste streams at LBNL in May 1998.

Energy Technology Engineering Center (ETEC)

Size Reduction and Survey Inside of Contaminated Fuel Storage Tubes
A remote laser cutting and size reduction technique was applied to the dismantlement and waste management of radioactive components at the ETEC site. This project used an off-the-shelf laser and fiber optics system to deliver the laser beam to a controlled cutting site for the remote size-reduction of contaminated fuel storage tubes. Fuel Storage Tubes were size reduced longitudinally and circumferentially for subsequent inspection and possible decontamination. The **Laser Cutting and Size Reduction** (DDFA, ID:1477) technology is faster, safer, and generates less secondary waste and airborne contamination. It provided a cost savings over traditional methods and increased worker safety by eliminating contact with the contaminated pipe. The size-reduced components were inspected and the radiologically clean (or decontaminated) sections released as scrap instead of requiring radioactive disposal. This innovative technology was used at the ETEC site in July 1997.

Version 1